"Mathematics" applied to Chemistry.

IN his notice of my book "Researches on the Affinities of the Elements" in NATURE, November 16, the reviewer impugns the legality of applying mathematical formulæ to my surfaces. I trust I may be allowed to answer briefly my critic's objections. His difficulty as to the non-continuous nature is imaginary, and arises from a mistaking of the object to be achieved—which is simply to obtain either a surface or a mathematical expression from which *can* be deduced the affinities any one element exhibits for any other. This can be done from the formulæ, and they do, therefore, characterise the chemical properties of an element which depend upon these affinities. Although there exist an infinite number of points on the surface which are occupied by no element, yet there exist only a *finite* number of points the x and y coordinates of which are *whole* numbers, and to *every* integer value given to x and y in my formulæ there corresponds a definite element; so that, so long as we keep within the domain of integer numbers (as we are forced to do by the nature of the construction) continuity is attained.

The complexity of the formulæ is more apparent than real, because the only values which x and y can have are integer numbers, and the constant and many terms disappear in practice. GEOFFREY MARTIN.

Kiel, December 6.

IT is true that the plan proposed by Mr. Martin is occasionally used on the convention that only the values of the equations to the curve which occur at the integer points are to be used; but the reviewer still maintains that the principle is a false one. A curve is intended to exhibit *continuous* change, according to some law, and he is unaware that any result of value has ever been obtained by the use of the plan, except, perhaps, that of appealing to the visual sense. THE REVIEWER.

Heat a Mode of Motion in the Seventeenth Century.

THE following statement occurs in the "Medulla Medicinæ," by J. A. Van der Linden, Med. Prof., Franekeræ, 1642, p. 182:—

"Calor est minutissimarum materiæ partium motus in se reverberatus."

Van der Linden was a famous teacher, but the theory may not have originated with him. Are there other co-temporary anticipations of "Heat a mode of motion"?

W. R. GOWERS.

THE PULSE OF THE ATMOSPHERIC CIRCULATION.

SOME fifteen years ago an American eclipse expedition which included Prof. Cleveland Abbe visited St. Helena, and, on leaving represented to the Governor, Mr. R. L. Antrobus, now of the Colonial Office, the importance of establishing a meteorological observatory there. The representation was sent to the Colonial Office, and, the colonial finances being then in a depressed condition, the Colonial Office applied to the Meteorological Council for assistance.

It is needless to spend many words over the meteorological importance of such an enterprise. St. Helena emerges from the sea in the heart of the trade wind of the southern Atlantic. In no part of the globe, perhaps, is the trade wind current so persistent. The trade winds have long been recognised as primary factors of the atmospheric circulation. Speculation on their origin, which still forms the staple of the physical geography of the schools, carries us back to the writings of Halley and Hadley. The south-easterly current over St. Helena is the flow along the main artery of the never-failing atmospheric circulation, and at St. Helena if anywhere we may put our finger on the pulse of that endless and complex process of transformation of solar energy of which the weather of our islands and elsewhere is an expression.

The council, itself not wealthy, had a Robinson anemograph, then lately returned from duty in Heligoland. This was lent to the colony, and with it was found a small annual sum by way of payment for its curator, Mr. Hands, of St. Matthew's Vicarage, who undertook as well the duties of observer for a normal station of the second order, with instruments furnished by the council.

The anemometer continued its run with some unavoidable interruptions, and the observations were taken until the middle of 1904. There are besides observations of rainfall at other stations in the island.

By 1904 that part of the spiral of the direction pencil which had to record south-easterly winds became so worn by constant use that a hollow was formed there and the record had become an unsatisfactory one. With the assistance of the engineer officers stationed at St. Helena the matter was inquired into, and, as a result, the instrument was ordered home for repairs. At the same time an attempt was made in the observatory branch of the Meteorological Office to put together the results of the long run and to collate them with the other observations. I will not anticipate the publication of the results which, I hope, will follow in due course, but to one interesting side of them, too speculative for an official report and too suggestive to be altogether ignored, I would like to direct attention, because it shows a possibility (perhaps more) that with more searching we may find a working connection between the pulsations of the trade wind in the southern hemisphere and the general type of weather in so distant a part of the globe as our own islands.

While the trade winds may be regarded as the most obvious representative of the dynamical effect of solar energy, rainfall must be allowed to be also very closely connected with the process of distribution of that energy. The convection of heat by evaporation from warm water surfaces and condensation in cooler regions represents a process tending towards equalisation of thermal distribution on a gigantic scale. The main directions of transference are from south to north on the one hand, and generally eastward from sea to land on the other. The white snow coverings of the polar regions and the persistent rivers of great continents are permanent records of nature's endeavour to distribute more nearly equally over the globe the supply of solar heat. From a general point of view rainfall or snowfall in the temperate and arctic zones may be regarded as an index, perhaps a spasmodic one, of the general circulation from the tropical regions towards the poles, and to that extent as the counterpart or correlative of the kinetic energy of the trade winds which represent the flow towards the equatorial region. The transformation of energy in rainfall is on a vastly greater scale than that displayed by the trade winds. Supposing that the trade wind at St. Helena is a mile high, the energy represented by the year's flow in a slice of the current a mile in width would be about equal to that represented by a year's rainfall on a single square mile in the neighbourhood of London. Of these two indices of the general process of distribution of solar energy, the one is the steadiest, the other the most fluctuating of all meteorological phenomena, and any indication of an underlying relation between them, which is, in a way, a necessity of the general process of circulation, would be of great meteorological interest and might be of immense economic importance.

So far as I have carried it, the study is perhaps

merely tantalising, but I should like to present the case as it occurred. When the figures for the average wind velocity were being put together, I inquired about the variation from year to year. The monthly values had not been combined, and a glance showed the last year (1903) to be one of exceptionally high velocity. For the complete year, since calculated, it is twenty-one miles per hour; the average for the twelve years is eighteen miles per hour. I noted 1903 as the year of heavy rainfall in this country, and asked about 1893, the year of drought, especially in the spring months. I found the wind velocities at St. Helena were for the first half

Jan.	Feb.	Mar.	Ap.	May	June	
16	14	—	15	14	—	in 1893,

as against

Jan.	Feb.	Mar.	Ap.	May	June	
21	20	16	20	16	19	in 1903.

The first two are the lowest velocities of those months on record; the others are low, but not the lowest. The blanks mean that the instrument was not working properly. This suggested some sort of connection, a stronger trade wind being associated with a heavier rainfall in this country. I obtained the monthly values and plotted the several years' variation. There was unmistakable evidence of a large seasonal variation with a maximum in September and a minimum in May. I plotted the average seasonal variation of the St. Helena wind for the twelve years, and against it the seasonal rainfall in the south of England for thirty-five years, which I happened to have at hand. The curves are reproduced in the figure (Fig. 1). The similarity is surprising. Of course, the seasonal rainfall is not the same in all localities, even in the British Isles. Somewhat similar curves are, however, to be found for Stykkisholm, in Iceland, and for Hakodate, in Japan, so that the case was not quite an isolated one. I was, therefore, not without hope that the evidence for organic connection would develop with further investigation. When plotting the curves of wind velocity for individual years, I noted that 1898 was an exceptional year, because it had two maxima of wind velocity, one in March and one in October, instead of the usual single one in September. Some information that I had for Southampton seemed to indicate a similar state of things for rain in England (south) in that year. I had the monthly rainfall figures for England (south) computed for each year, and looked at once to those for 1898. Here are the figures for the two variables compared for that year.

St. Helena wind velocity—

Miles per hour

Jan.	Feb.	Mar.	Ap.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
19	19	22	20	19	16	16	15	22	24	20	20

South of England rainfall—

Inches

Jan.	Feb.	Mar.	Ap.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
0·71	1·58	1·12	1·39	3·59	1·46	0·49	1·37	0·99	3·48	3·67	2·86

There is unmistakably the second maximum of rainfall. It is in May, generally the driest month, two months after the unusual second maximum of wind velocity at St. Helena. The ordinary autumnal maximum of rainfall is delayed a month until November, just as the wind maximum is delayed a month until October.

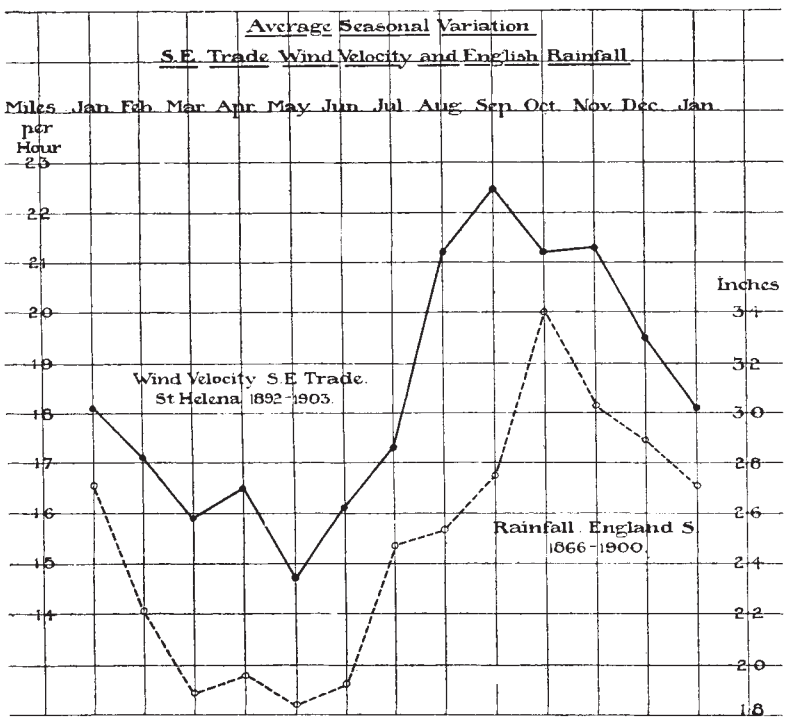

FIG. 1.

As a test case this seemed to be almost conclusive and the connection to be put beyond doubt, but in meteorological matters there are many disappointments. Some goblin seems to be in possession of this castle in the air; we see a glimpse of light; knock at the door; the goblin opens it almost wide enough to let us in, and then he slams it in our faces with a laugh. One can almost hear the mischievous Puck crowing to the

"Captain of our fairy band,
Helena is here at hand,
And those things do best please me
That befall preposterously."

There is even a faint echo of the wicked exclamation

"Lord, what fools these mortals be!"

When one turns from the average of years to the individual years, after the curious test case of 1898 one must confess that while the seasonal variation is maintained fairly well in the trade wind, year by year, one cannot recognise it in the rainfall. There appears, perhaps it is hardly necessary to say so, to be no regular seasonal variation in a single year of English rainfall. Any month may be the wettest month or perhaps the driest, and so a fitful parallelism is rudely interrupted by a wet July or some unaccountable abnormality. The phenomenally wet year, 1903, is truly the year of greatest trade wind velocity, but the order of wind velocity is not regularly the order of rainfall values; one wonders whether the recorder has always been working as one would wish; and when the monthly rainfall average is taken for the twelve corresponding years instead of the thirty-five years, the curious

subsidiary maximum in April so neatly reproduced in the St. Helena wind has disappeared, owing principally, be it said, to an abnormally dry April in 1893.

Yet the evidence in favour of a connection can hardly be pure coincidence. The little rain maximum in April is not mere illusion. The fact that a seasonal variation of rainfall does show itself in the average of a few years has a meaning, and that its phases are closely similar to those of the arterial pulsations of the general atmospheric circulation accords too much with what may be called common sense to be altogether devoid of significance.

Sooner or later we shall catch the nimble imp that jeers at us to-day, and, if I mistake not, when he is caught we shall make him tell us something of the real secrets of these atmospheric relationships.

There are two considerations that may be mentioned. A disproportionately large fall of rain is sometimes regarded as an accident of little or no influence upon general meteorological conditions, but in view of the enormous quantities of energy involved that view can hardly be seriously maintained. It is true that on some days we get thunderstorms with heavy rain distributed in a most irregular manner, and for these at present no satisfactory explanation can be given, but it should be looked for seriously. Secondly, the rainy movements of the atmosphere in this part of the world are, as already mentioned, a south to north movement and a west to east movement. Perhaps we may in time be able to disentangle the effects of the various causes and find the regular sequence at present overlaid by the influence of secondary disturbing causes.

I have ventured to put forward these suggestions, which I frankly confess are deplorably bizarre, because my readers may have at their disposal methods, that I am ignorant of, by which a crucial test may be applied to the question whether there is any definite and, shall I say, useful connection between the pulsations of the south-east trade wind and the rainfall of north-western Europe.

W. N. SHAW.

TWO BOOKS ON ANIMAL BIOGRAPHY.[1]

IN the second of these two works the author expresses the opinion that the first question which will be asked by the reader is whether the various anecdotes are strictly true. The question that presents itself to our mind is whether such books will be read at all, and if so by whom? The professional naturalist, we dare venture to say, will have nothing to do with them; they are not apparently intended for children, and for our own part we confess that to read them for either pleasure or instruction is about the last thing we should think of doing. They are what may be called "animal novels," and thereby differ to a considerable extent from the old-fashioned "animal biographies," under which heading we have, however, ventured to include them. In each instance the author takes a number of more or less well-known animals, and recounts their ordinary everyday life, so far as it can be interpreted, Mr. English giving this for the most part in what are supposed to be the creature's own words, while the American author mingles verbal with descriptive narrative. Both works are, no doubt, excellent in their own particular way; and, for the sake of authors and publishers alike, we trust that a sufficient number of readers exist to whom this style of writing appeals with infinitely greater force than it does to ourselves. To such we may commend each of the two works, for, in the respective subjects, we find little to choose between them.

Mr. English, very appropriately, confines himself to British animals (including mammals, birds, fishes, insects, &c.); and although we cannot congratulate him on the title he has selected for his volume, we are pleased to be able to record our high appreciation of his skill as a photographer, and of the excellent manner in which his pictures have been reproduced.

FIG. 1.—The Wood-mouse. From English's "Beasties Courageous."

The photograph of the wood-mouse herewith presented to our readers is absolutely exquisite, and cannot be surpassed. Moreover, it is by no means a solitary example of excellence, every picture in the book being of high quality, although some are, of course, better than others. As a picture-book of various types of British animal life the book would be hard indeed to beat.

Mr. Long, on the other hand, takes for his subject some of the more striking animals of the Arctic districts of North America, which he calls for the most part by their native Indian names, after the manner of "Hiawatha."

The first six chapters are, for instance, devoted to the white wolf, under the title of "wayeeses, the strong one"; but it is a little remarkable to note that in the glossary at the end of the volume this name is spelt "wayeesis." Other chapters follow on the wild goose ("waptouk"), the fisher-marten ("pequam"), the salmon, &c. All bear the impress of truth, and relate the experiences of one who has seen the animals in their native wilds. The most striking incident is perhaps the one depicted on the cover of the book, where the author had the good fortune

[1] "Beasties Courageous; Studies of Animal Life and Character." By D. English. Pp. viii+121; illustrated. (London: Bousfield and Co., Ltd., 1905.) Price 5s. net.

"Northern Trails; some Studies of Animal Life in the Far North." By W. J. Long. Pp. xxv+390; illustrated. (Boston, U.S.A., and London: Ginn and Co.). Price 7s. 6d.